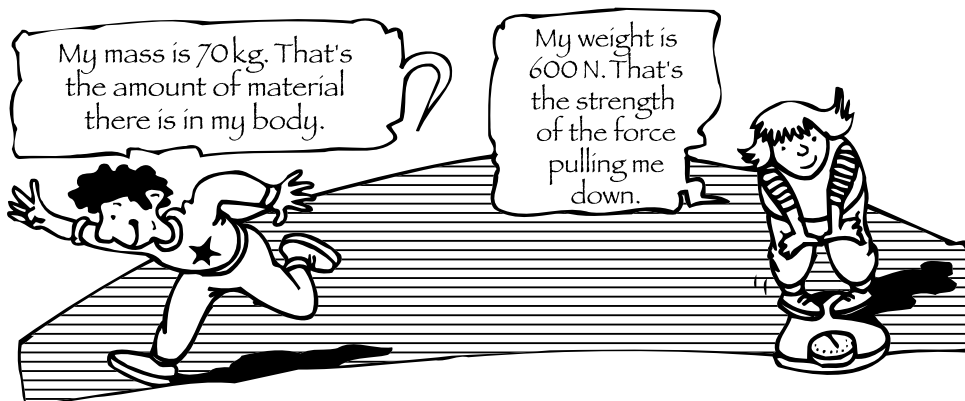


G1 Mass and weight

Mass



Your body is made up of billions and billions of atoms and molecules ... far too many to count! Instead we measure how much 'stuff' there is in your body in kilograms. This is your **mass**.

Weight

When you stand on the surface of the Earth there is a gravitational attraction between you and the Earth. The size of this force is your **weight**.

If your weight is 750 N this means there is a gravitational attraction (force) between you and the Earth of 750 N.

The gravitational field strength (g) on the Earth is 10 N/kg. This means that if an object has a mass of 1 kg, its weight will be 10 N. If it has a mass of 2 kg, its weight will be 20 N. We can write this relationship as a simple equation

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

$$w = m \times g$$

Example: Calculate the weight of an object that has a mass of 50 kg:

$$w = m \times g$$

$$w = 50 \text{ kg} \times 10 \text{ N/kg}$$

$$w = 500 \text{ N}$$

Questions

- 1 Calculate the weight of the following objects on the Earth, where the gravitational field strength is 10 N/kg.
 - a Object A which has a mass of 50 kg
 - b Object B which has a mass of 150 kg
 - c Object C which has a mass of 100 g (0.1 kg)
- 2 Calculate the mass of each of the following objects, where the gravitational field strength is 10 N/kg.
 - a Object D which weighs 2500 N
 - b Object E which weighs 48 N
 - c Object F which weighs 8 N

G2 Masses and weights on different worlds



Imagine you are standing on the surface of a different world, for example on the planet Neptune. The amount of stuff that you are made of would be the same as on Earth – your mass would not change. But because you are on a planet with a mass that is very different from the mass of the Earth, the gravitational attraction between you and the planet *will* be different, and so your weight will differ.

We can calculate your new weight using the formula: $w = m \times g$

But the value for g will now be different from the value you used when calculating the weights of objects on the Earth.

Example: The gravitational field strength on the Moon is 1.6 N/kg. Calculate the weight of an object on the surface of the Moon if its mass is 10 kg:

$$w = m \times g$$

$$w = 10 \text{ kg} \times 1.6 \text{ N/kg}$$

$$w = 16 \text{ N}$$

Questions

1 Determine the weights of objects A, B and C if they are measured on the surface of the Earth.

- a Object A has a mass of 12 kg
- b Object B has a mass of 25 kg
- c Object C has a mass of 0.5 kg

The gravitational field strength on the Earth is 10 N/kg.

2 Determine the masses and the weights of objects A, B and C if they are measured on the surface of the Moon. The gravitational field strength on the Moon is 1.6 N/kg.

3 Determine the masses and weights of objects A, B and C if they are measured on the surface of the planet Jupiter. The gravitational field strength on Jupiter is 2.4 times that of the gravitational field strength on the Earth. The gravitational field strength on the Earth is 10 N/kg.

G3 Planets in our Solar System (extension)

Planet	Distance from Sun in millions of km	Diameter in km	Mass compared with the Earth	Number of moons	Length of day in Earth days	Length of year in Earth years	Average temperature in °C	Gravitational field strength (gravity) (N/kg)
Mercury	58	5 000	0.05	0	59	0.24	350	4
Venus	108	12 000	0.80	0	243	0.6	460	9
Earth	150	12 800	1.0	1	1.0	1.0	15	10
Mars	228	7 000	0.1	0	1.0	1.9	-25	4
Jupiter	779	140 000	318	16	0.4	11.9	-120	24
Saturn	1427	120 000	95	23	0.4	29.5	-180	10
Uranus	2670	52 000	15	15	0.5	84	-200	8
Neptune	4496	52 000	17	8	0.7	165	-220	12
Pluto	5906	3 000	0.1	1	6.4	248	-240	4

Questions

Use the information in the table to answer these questions.

- Which planet is nearest the Sun?
- Which planet is furthest from the Sun?
- Which planet has the largest mass?
- Which planet has the smallest mass?
- Which planet is nearest the Earth?
- What is the length of the day on the planet with the highest average surface temperature?
- What is the average surface temperature of the planet that has the same gravitational field strength as the Earth?
- How many planets have fewer moons than the Earth, but have a stronger gravitational field strength?
- How many planets have a mass that is greater than the mass of the Earth?
- On which planet would a box weighing 20 N on the Earth have a weight 24 N?
- What is the diameter of the planet that has the same length of day as the Earth?
- What is the total number of moons orbiting the two planets that have the same diameter?
- A space traveller visits all of the planets in our Solar System and weighs himself on each. On which three planets does he weigh the same?
- If the traveller in question 13 has a mass of 80 kg, what would his weight be on these three planets?
- If all the planets were in a line and on the same side of the Sun, which two planets would be closest, and what would be the distance between them?
- Which is the only other planet in our Solar System that might be able to support life? Give a reason for your answer.
- Which planet is spinning twice as fast as the Earth?
- Which planet spins around most slowly?
- Which planet takes almost twice as long as the Earth to orbit the Sun?
- Which planet has the highest density?
(Hint: density = mass/volume)